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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/646,709

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Sadayuki Ohnishi

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06/01/2006

SUGHRUE MION, PLLC
2100 PENNSYLVANIA AVENUE, N.W.
SUITE 800
WASHINGTON, DC 20037

EXAMINER

CAO, PHAT X

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 06/01/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/646,709

Applicant(s)

OHNISHI, SADAYUKI

Examiner

Phat X. Cao

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 09 February 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-13 and 25-35 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-13 and 25-35 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

1. The Request for Continued Examination filed on 2/9/06 is acknowledged.
2. The cancellation of claims 14-24 in Paper filed on 2/9/06 is acknowledged.
3. The indication of allowability of claims 1-13 and 25-26 are withdrawn because of the new ground of rejections.

Drawings

4. Figures 1-3 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

5. Claim 1 is objected to because of the following informalities: in claim 1, line 1, a symbol ":" should be added right after "in order". Appropriate correction is required.

Claim Rejections - 35 USC § 112

6. Claims 1-13 and 25-26 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably

convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

- In amended independent claim 1 filed on 11/9/05, lines 1-2, a phrase "...a semiconductor substrate which acts as a first copper diffusion barrier layer" is not supported by the original disclosure. For example, Fig. 4 of Applicant's invention discloses a dielectric film 100 formed on a semiconductor substrate (not shown, see Fig. 13), made of SiCN, and having a dielectric constant $k = 4.8$ (see Applicant's specification, page 10, line 17 and page 11, line 22). The SiCN dielectric film 100 serves as a first copper diffusion barrier layer (see Applicant's specification page 10, line 17), but not the semiconductor substrate as amended. Therefore, having a semiconductor substrate functioning as a first copper diffusion barrier layer is not supported by the original disclosure.
- Dependent claims 2-13 are also rejected because they depend from amended independent claim 1.
- In amended claim 25 filed on 5/31/05, lines 7-10, a phrase " wherein a second adhesive film constituted essentially by a silicon-based compound having an aromatic ring in a molecule of said silicon-based compound having a specific dielectric constant of 2.5 to 2.6 is formed between a SiCN layer and said low dielectric constant film" is not supported by the original disclosure. For example, Fig. 6 of Applicant's invention discloses a stack of interconnect structure comprising an interlayer dielectric film (120,102) including a lamination consisting essentially of a first adhesive film 120 and a low dielectric constant film 102; a SiO layer 107; a SiCN film 108; a second

adhesive film 110; and another low dielectric constant film 112. Clearly, the second adhesive film 110 is not formed between the SiCN layer 108 and the said low dielectric constant film 102. Therefore, having a second adhesive film formed between a SiCN layer and the low dielectric constant film is not supported by the original disclosure.

- Similarly, in amended claim 26 filed on 5/31/05, lines 7-10, a phase " wherein a second adhesive film constituted essentially by a silicon-based compound having an aromatic ring in a molecule of said silicon-based compound having a specific dielectric constant of 2.5 to 2.6 is formed between a SiO layer and said low dielectric constant film" is also not supported by the original disclosure because Fig. 6 of Applicant's invention does not show that the second adhesive film 110 is formed between a SiO layer 107 and said low dielectric constant film 102 as claimed.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 27, 29-30, and 32-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Barth et al (US. 2004/0173908) in view of Lee (US. 2003/0067077).

Regarding claims 27 and 29-30, Barth (Fig. 1) discloses a semiconductor substrate 10, and a metal wiring 15 and an interlayer dielectric film (17,18,19) which are formed on the semiconductor substrate 10, the interlayer dielectric film (17,18,19)

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including a multi-layered structure consisting of: a diffusion barrier film 17 preventing diffusion of the metal out of the metal wiring 15 (par. [0006], last 3 lines), an adhesive film 18 (par. [0007]) formed directly on the diffusion barrier film 17, and a low dielectric constant film 19 of polymeric thermoset material (i.e., SILK) (par. [0008], lines 1-7) formed directly on the adhesive film 18, and the low dielectric constant film 19 (or 119 in Fig. 2) being constituted essentially by an organic low dielectric constant material having a specific dielectric constant not greater than 4 (par. [0031]).

Barth does not disclose that the adhesive film 18 is a silicon-based compound of BCB having an aromatic ring.

However, Lee (Fig. 1l) teaches an interlayer dielectric film formed on a metal wiring 116a, the interlayer dielectric film including: a lamination consisting of an adhesive film 118 constituted by a silicon-based compound of benzocyclobutene (BCB) having a benzene ring (aromatic ring) in its molecule (par. [0019]), and an organic low dielectric constant film 120 having a specific dielectric constant not greater than 4 (pars. [0014] and [0021]) formed directly on the adhesive film 118. Accordingly, it would have been obvious to form the adhesive film 18 of Barth with the material as set forth above because as taught by Lee, such BCB adhesive layer would provide a good adhesion to the metal wiring layer/organic dielectric layer and would prevent a crack issue (par. [0019]).

Regarding claims 32-34, Barth further discloses that the organic low dielectric constant material 19 (Fig. 1) or 119 (Fig. 2) is a silicon-containing organic compound of methylsilsequioxane or SiOC (par. [0031]).

Regarding claim 35, Barth's Fig. 1 also discloses the interlayer dielectric film (17,18,19) is formed on the metal wiring 15.

9. Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Barth et al and Lee as applied to claim 27 above, and further in view of Applicant's admitted prior art.

Barth discloses the diffusion barrier film 17 being made of SiN (par. [0006], last 3 lines), but does not disclose the diffusion barrier film 17 being made of SiCN.

However, Applicant's admitted prior art (Fig. 3) teaches the contact structure including a diffusion barrier film 108 of SiCN formed on a metal wiring 106. Accordingly, it would have been obvious to substitute SiN with SiCN because they both have the same function as a diffusion barrier film for preventing diffusion of the metal out of the metal wiring.

10. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Barth et al and Lee as applied to claim 27 above, and further in view of Lauterbach et al (US. 6,313,517).

Neither Barth nor Lee disclose that the silicon based compound is a polymer formed through polymerization of a monomer containing a divinylsiloxane bisbenzocyclobutene unit.

However, Lauterbach (column 3, lines 50-66 through column 4, lines 1-16) teaches the forming of an adhesive BCB, the adhesive BCB is a polymer silicon-based compound formed through polymerization of a monomer containing a divinylsiloxane bisbenzocyclobutene unit. Accordingly, it would have been obvious to form the BCB

polymer layer of Lee with a BCB polymer containing a divinylsiloxane bisbenzocyclobutene because such BCB polymer would provide a good adhesion to semiconductor, oxide, nitride and metal layers, as taught by Lauterbach (column 4, lines 8-14).

Response to Arguments

11. Regarding new claims 27-35, in response to Applicant's argument that Lee does not disclose an adhesive film formed between a low dielectric constant film and a diffusion barrier film as claimed, the U.S. reference, issued to Barth, is cited in the ground of rejection for showing the feature above (see the ground of rejections for details).

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phat X. Cao whose telephone number is 571-272-1703. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 571-272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

PC
May 28, 2006


PHAT X. CAO
PRIMARY EXAMINER